

1. (first amendment) A thermally-integrated [low temperature] water-gas shift reactor for converting reformat gases including carbon monoxide in the presence of steam to form carbon dioxide and water comprising, in combination,

a) a waste-heat recovery steam generator for the [beneficial] recovery of exothermic reaction heat to generate steam [that is used in a process for the conversion of hydrocarbon feedstock into hydrogen-rich gases],

b) an outer region extending at least part way about said waste-heat recovery steam generator,

c) a catalyst bed located within said outer region, and through which reformat gases flow, said bed extending helically, there being flow guide surfaces extending helically adjacent the catalyst to direct gases to flow helically through the bed,

d) the outer region being in heat transfer communication with the steam generator to maintain the catalyst bed within a predetermined temperature range for operation of a [low temperature] water-gas shift reaction producing said exothermic reactor heat.

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2. (first amendment) The combination of claim 1 wherein the waste heat steam generator operates at temperatures in one of the following ranges: 360°F to 450°F, and of 385°F to 400°F, that is optimum for conducting the [low temperature] water-gas shift reaction.

B1 3. (first amendment) The combination of claim 1 wherein said bed includes a Cu/Zn catalyst which is contained in [an annular] space defined by said outer region, and [having] there being an inner wall adjacent said space and that is in thermal contact with a boiling water fluid in said generator.

4. (first amendment) The combination of claim 3 wherein the boiling water fluid is located [to transfer heat to the catalyst] proximate the bed to heat the bed during start-up.

5. (first amendment) The combination of claim 3 wherein the catalyst bed [is located] extends helically about said waste heat recovery steam generator to transfer heat to the boiling water fluid [during normal operation to generate steam].

B) 6. (first amendment) The combination of claim 1 including [longitudinal] heat transfer fins [attached to an inside wall of the annulus and] projecting in said bed to enhance the rate of heat transfer to and from the catalyst bed.

7. (first amendment) The combination of claim 1 including [a helical coil adjacent the] inner and outer walls for defining annular space, and a helical coil at said [annulus] space to conduct and increase the velocity of the [process] gases as they flow helically through the catalyst bed and to enhance the rate of heat transfer to and from the catalyst bed.

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8. (first amendment) The combination of claim 1 wherein the catalyst bed is sufficiently close to said generator to be maintained in one of the following ranges: between 370°F and 550°F, and between 400°F and 450°F.

61 9. (first amendment) The combination of claim 3 including outside and inside walls defined by said space, and wherein the [annular] space is [typically] between 1 and 2 inches wide to minimize temperature differentials between the outside and inside walls [defined by the annular space].

10. (first amendment) The combination of claim 3 wherein the bed has helical length characterized in that the [gas has] gases have hourly space velocity in the range of 500hr⁻¹ to 2000hr⁻¹.

11. (first amendment) The combination of claim 1 wherein the waste heat stem generator contains one or more heat transfer conduits that transfer heat from [hot] combustion products to a boiling water fluid for the purpose of generating steam.

B1 12. (first amendment) The combination of claim 1 wherein the steam generator includes an upright vessel, said outer region having an upper level inlet flowing reformat gases into the catalyst bed, the reformat gases [containing] including carbon monoxide, and said region having a lower level outlet, [a catalyst bed located between said upper and lower levels,] a heat transfer conduit or conduits extending within said vessel and immersed within boiling water contained in said vessel inwardly of said catalyst bed, said conduit or conduits [receiving hot products of combustion from a combustion process,] operable for transfer of heat to the boiling water, for generating steam exiting from said vessel.
